

Stratigraphy of the layered terrain in Valles Marineris, Mars

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The layered terrain in Valles Marineris provides information about its origin and the geologic history of this canyon system. Whether the terrain is sedimentary material deposited in a dry or lacustrine environment, or volcanic material related to the tectonics of the canyon is still controversial. However, recent studies of Gangis Layered Terrain [1] suggests a cyclic sequence of deposition and erosion under episodic lacustrine conditions.

We extended our stratigraphic studies to four other occurrences of layered terrains in Valles Marineris in an attempt to correlate and distinguish between depositional environments.

1) Juvantae Chasma: Juvantae Chasma contains two major layered deposits. One shows alternating thin conformable light and dark layers. The other similar deposit overlies chaotic terrain (figure 1), suggesting deposition after chaotic terrain formation. The thickness of the layers in both deposits is similar.

2) Hebes Chasma: Hebes Layered Terrain is a single deposit up to 5 km thick and described in detail by S. Croft (personal communication). The upper portion of this terrain (estimated to be a few hundred meters thick) consists of alternating dark and light layers which seem to form a less resistant cap-rock unconformably overlying a more massive unit. The lower unit exhibits very prominent fluting which dissects deeply in some parts of the cliff. In the eastern end of the layered terrain, the cap-rock has been eroded away exposing the top of the massive unit which has been severely fluted (figure 2). This suggests that these two major units have very different physical properties. Furthermore, the canyon wall material exhibits an even different erosional style indicating it has still different mechanical properties.

3) Ophir and Candor Chasmata: There are four main layered terrains (A,B,C,D) in these two connected chasmata. The lower sections of layered terrain B, C and D are composed of massive weakly-layered units which often, but not always, develop prominent fluting on their slopes. The fluting tends to be continuous from the top to the bottom of these units. C and D in Candor Chasma show very fine layers on the slopes of the non-fluted areas. In limited areas of the massive weakly-layered units of A and B in Candor, and C in Ophir Chasma, fine layers have been accentuated by the erosion. In the massive weakly-layered units (A,B and D), there is at least one relatively thick low albedo layer (figure 3). Terrain B, C and D's uppermost layers have a different erosional style than the lower massive weakly-layered units. These top layers seem to have a steeper slope, and in many cases, a fine horizontal layered structure.

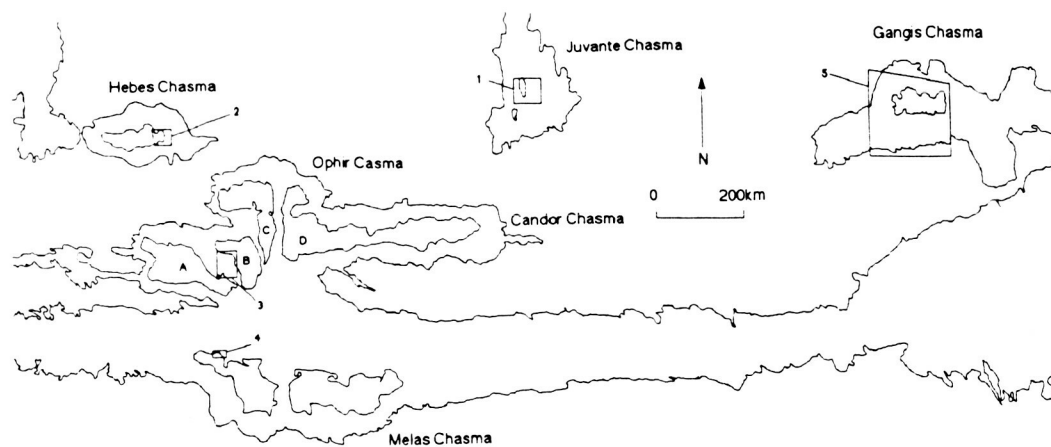
4) Melas Chasma: There are two major layered terrains located in the southern part of this Chasma (figure 4). They are both highly dissected by erosional processes and exhibit both accentuated fine and dark layers.

5) Gangis Layered Terrain's structure is composed of three major layers [2] (figure 5). The upper two layers have steep slopes, many sublayers, and overlie unconformably a massive, fluted unit. Probable dikes and domes have intruded and been exposed in this terrain.

Although there are broad similarities among the layered terrains, no two deposits are exactly alike. This suggests that there was no synchronized regional depositional processes to form all the layered deposits. However, the similar erosional style of the lower massive weakly bedded unit in Hebes, Gangis and Ophir-Candor suggests it may have been deposited under similar circumstances. There is a fairly good correlation of layered units within individual chasma (Juvantae, Melas and Ophir-Candor Chasmata). This suggests that each layered terrain formed under a similar depositional environment. Nedall et al. [1] suggested a possible correlation of layers between terrains B and D in Ophir-Candor Chasmata. Layered terrains in Ophir-Candor Chasmata are separated, but they all have a similar lower weakly bedded unit (A, B, C, D), often with dark layers (A, B, D), and an upper thinner layered unit (B, C, D). All four terrains have similar maximum thicknesses (5000-6000m). Hence, the layered terrains in Ophir and Candor chasmata (A, B, C, D) may have been connected and deposited in a similar environment. If they were connected, they were breached and eroded, probably by fluvial processes and later modification by eolian action. Catastrophic outflow of ponded water from the closed canyon as suggested by Lucchitta and Ferguson [3] might be responsible for this erosion. Two layered terrains in Melas Chasma are severely eroded, and some layers of both terrains are about same thickness suggesting a similar depositional environment. Two major layered terrains in Juvantae Chasma also may have formed under similar circumstances suggested by similar thickness of the layers in both terrains. The layered terrain in each chasma seems to have had a separate stratigraphic history and somewhat different depositional environments in which water played a major role.

REFERENCES

- [1] Nedall et al. (1987). *Icarus*, 70, 409-441. [2] Komatsu, G. and Strom, R.G. (1990). *Lunar and Planet. Sci.* 21, 651-652 [3] Lucchitta, B.K. and Ferguson, H.M. (1983). *Proc. Lunar and Planet. Sci.* 13, A553-A568.



Location map of the layered terrains in Valles Marineris. 1, 2, 3, 4, and 5 correspond to the figures. See text for A, B, C and D.

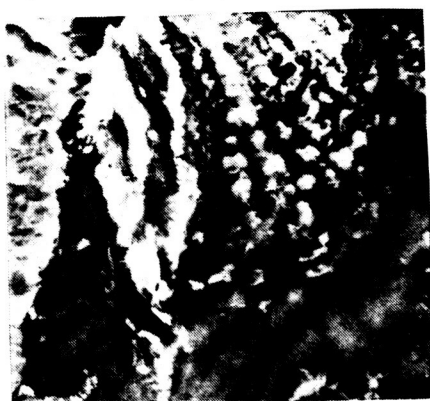


Figure 1.



Figure 2.



Figure 4.



Figure 5.



Figure 3.